Curved Clamp Arm Tissue Pad Attachment For Use With Ultrasonic Surgical Instruments

Field of the Invention

The present invention relates, in general, to ultrasonic surgical clamping instruments and, more particularly, to a curved clamp arm tissue pad attachment for use with ultrasonic surgical instruments.

Background of the Invention

This application is related to the following copending patent applications: Application Serial No. 08/948,625 filed October 10, 1997; Application Serial No. 08/949,133 filed October 10, 1997; Application Serial No. 09/106,686 filed June 29, 1998; Application Serial No. 09/337,077 filed June 21, 1999; Application Serial No. 09/---,--- [Attorney Docket No. END-616]; Application Serial No. 09/---,--- [Attorney Docket No. END-617]; and Application Serial No. 09/---,--- [Attorney Docket No. END-618] which are hereby incorporated herein by reference.

Ultrasonic instruments, including both hollow core and solid core instruments, are used for the safe and effective treatment of many medical conditions. Ultrasonic instruments, and particularly solid core ultrasonic instruments, are advantageous because they may be used to cut and/or coagulate organic tissue using energy in the form of mechanical vibrations transmitted to a surgical end-effector at ultrasonic frequencies. Ultrasonic vibrations, when transmitted to organic tissue at suitable energy levels and using a suitable end-effector, may be used to cut, dissect, or cauterize tissue. Ultrasonic instruments utilizing solid core technology are particularly advantageous because of the amount of ultrasonic energy that may be transmitted from the ultrasonic transducer through the waveguide to the surgical end-effector. Such instruments are particularly suited for use in minimally invasive procedures, such as endoscopic or

laparoscopic procedures, wherein the end-effector is passed through a trocar to reach the surgical site.

Ultrasonic vibration is induced in the surgical end-effector by, for example, electrically exciting a transducer which may be constructed of one or more piezoelectric or magnetostrictive elements in the instrument hand piece. Vibrations generated by the transducer section are transmitted to the surgical end-effector via an ultrasonic waveguide extending from the transducer section to the surgical end-effector.

Solid core ultrasonic surgical instruments may be divided into two types, single element end-effector devices and multiple-element end-effector. Single element end-effector devices include instruments such as scalpels, and ball coagulators, see, for example, U.S. Patent No. 5,263,957. While such instruments as disclosed in U.S. Patent No. 5,263,957 have been found eminently satisfactory, there are limitations with respect to their use, as well as the use of other ultrasonic surgical instruments. For example, single-element end-effector instruments have limited ability to apply blade-to-tissue pressure when the tissue is soft and loosely supported. Substantial pressure is necessary to effectively couple ultrasonic energy to the tissue. This inability to grasp the tissue results in a further inability to fully coapt tissue surfaces while applying ultrasonic energy, leading to less-than-desired hemostasis and tissue joining.

The use of multiple-element end-effectors such as clamping coagulators include a mechanism to press tissue against an ultrasonic blade, that can overcome these deficiencies. A clamp mechanism disclosed as useful in an ultrasonic surgical device has been described in U.S. Patent Nos. 3,636,943 and 3,862,630 to Balamuth. Generally, however, the Balamuth device, as disclosed in those patents, does not coagulate and cut sufficiently fast, and lacks versatility in that it cannot be used to cut/coagulate without the clamp because access to the blade is blocked by the clamp.

Ultrasonic clamp coagulators such as, for example, those disclosed in U.S. Patents No. 5,322,055 and 5,893,835 provide an improved ultrasonic surgical instrument for cutting/coagulating tissue, particularly loose and unsupported tissue, wherein the ultrasonic blade is employed in conjunction with a clamp for applying a compressive or biasing force to the tissue, whereby faster coagulation and cutting of the tissue, with less attenuation of blade motion, are achieved. However, clamp coagulating instruments such as described in U.S. Patents No. 5,322,055 and 5,893,835 have been difficult to manufacture with curved end-effectors that can deliver sufficient energy to tissue, while maintaining the integrity of the ultrasonically active element.

Improvements in technology of curved ultrasonic instruments such as described in U.S. Patent Application Serial No. 09/106,686 previously incorporated herein by reference, have created needs for improvements in other aspects of curved clamp coagulators. For example, U.S Patent No. 5,873,873 describes an ultrasonic clamp coagulating instrument having an end-effector including a clamp arm comprising a tissue pad. In the configuration shown in U.S Patent No. 5,873,873 the clamp arm and tissue pad are straight.

Attachment of the tissue pad to the clamp arm of an ultrasonic surgical instrument is important, in that failure of the attachment may cause the tissue pad to be lost during a surgical procedure, thereby complicating the surgery. Because of this, tissue pad attachments utilizing keyed slots on one element and an associated key on an attachable element have been developed, such as, for example, pads described in U.S. Patent Application No. 09/337,077 previously incorporated herein by reference. U.S. Patent Application No. 09/337,077 describes, in one embodiment, a tissue pad having a T-shaped flange insertable into a clamp arm having a T-shaped slot.

Although attachments such as the T-shaped system described in U.S. Patent Application No. END-506 filed 6/21/99 are effective, difficulty arises when trying to bend or curve the end-effector. Slots such as disclosed above cannot be easily